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CITRUS DECLINES CAUSED BY NEMATODES IN FLORIDA. II. PHYSIOLOGICAL RACES

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Nematode races are defined here as those nematodes that cannot be distinguished morphologically and morphometrically one from the other, but have similar and different host preferences. Both the burrowing nematode, Radopholus similis, (Cobb, 1893) Thorne, 1949, the causal agent of spreading decline, and the citrus nematode, Tylenchulus semipenetrans, Cobb, 1913, the causal agent of slow decline, have races. Certain races of each are able to invade resistant and/or tolerant rootstocks which have been a primary means of pest management for both nematodes. A number of citrus species, citrus relatives, and hybrid rootstocks have been tested for resistance, but only a limited few have been worthy of release to growers.

The need for rootstocks resistant to the burrowing nematode was recognized as an essential part of a management program soon after that nematode was found to initiate spreading decline disease (7). Two citrus rootstocks, 'Milam' lemon (Citrus sp.) and 'Ridge Pineapple' (C. sinensis) were released to the industry in 1964 (9) as resistant rootstocks, defined here as rootstocks which may be invaded by low numbers of nematodes, but not enough to cause growth retardation. Later, 'Algerian' navel (C. sinensis) was added to this list (10). 'Carrizo' citrange (C. sinensis X P. trifoliata) was also considered resistant to the burrowing nematode; however, germplasm variability exists which has led to differences among cultivar response to this nematode (13). Estes rough lemon (C. jambhiri) rootstock, formerly classified as tolerant of the burrowing nematode (10), was later found to be susceptible (15).

Resistant rootstocks in Florida have been used for: 1) biological barriers against the spread of R. similis; 2) replants after pulling trees and fumigating the soil of infested groves; and 3) replacement trees in groves where only occasional infested trees were pulled. Because low numbers of the burrowing nematode are known to reproduce on these rootstocks, there has been concern that resistance-breaking biotypes may develop. During the past few years, burrowing nematode populations were found infecting and reproducing on Milam lemon rootstock in high numbers in two groves (17). This population was subjected to intensive testing on the several burrowing nematode resistant rootstocks. The population reproduced at significantly higher numbers than did the R. similis population which reproduces poorly on Milam lemon, Carrizo citrange, Albritton sweet, Algerian navel, and Ridge Pineapple orange rootstocks (14).

Thus, two physiological races are now known to exist in Florida citrus groves, one of which is able to cause spreading decline-like symptoms of dieback, defoliation, leaf discoloration, and general unthriftyness on burrowing nematode resistant rootstocks as well as other citrus rootstocks (Fig. 1). Growers should be aware of such a condition if suspicious symptoms occur in their groves.

DuCharme (6) first reported that trifoliate orange (Poncirus trifoliata) was resistant to the citrus nematode; others (2,5,8) reported certain selections of trifoliate orange, and some other plants botanically close to citrus, were highly resistant or immune to the citrus nematode. Poncirus trifoliata cultivars found most resistant to a Florida citrus race of Tylenchulus semipenetrans were 'Argentina', 'English Large', 'Large Flower', 'Pomeroy', and 'Rich 7-5'. Recently another hybrid rootstock, 'Swingle' citrumelo (C. paradisi X P. trifoliata) was shown to be

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highly resistant to the citrus nematode (12,16). Trifoliate orange and their hybrids continue to be the major source of resistance to the citrus nematode.

In Japan, a citrus nematode population readily attacks *P. trifoliata* (16). A similar physiological population that infests *P. trifoliata* was found in California (3) and later other biological populations were identified in California (1).

Finding of these apparently different biological populations with different host preferences led to a study to determine how many races of *T. semipenetrans* are presently known. Since no morphological differences separate races of *T. semipenetrans*, host preference is the only factor used in their characterization (11).

Experiments with the citrus nematode in several countries (16) indicated that at least four physiological races of citrus nematode exist and are probably widely distributed.

They are:

1. The "citrus race" (CR), reproduces very poorly or not at all on *P. trifoliata* but infects *Citrus* spp., Carrizo and 'Troyer' citrange, olive, grape, and persimmon. This race includes populations from North (Arizona, California, Florida, Texas), Central, and South America.

2. The "Mediterranean race" (MR) is very close to the citrus race and has the same host range, except that olive is not a host. This race is in all citrus-producing countries of the Mediterranean region and South Africa and perhaps in India.

3. The "Poncirus race" (PR) reproduces actively on *Citrus* spp., *P. trifoliata*, their hybrids, and grape, but not olive. This race probably originated in Japan and appears to be present in California. It is not known in the other citrus growing states in the U.S.

4. The "grass race" (GR) is presently known only from Florida. Juveniles were first detected in 1957 in soil from *Mikania batatifolia* near Indiantown, Florida. Its only known true host is *Schizachyrium rhizomatus* (18). However, juveniles have also been extracted from soil from around roots of the following additional plants in Florida: *Andropogon glomeratus*, *Arudinaia gigantia*, *Baccharis halimifolia*, *Cedrus* sp., *Cupressus* sp., *Cyrilla* sp., *Diospyros virginiana*, *Hymenocallis* sp., *Ilex americanum*, *Ilex glabra*, *Juniperus silicicola*, *Nyssa aquatica*, *Paspalum notatum*, *Pinus* sp., *Pinus caribaea*, *Pinus clausa*, *Quercus* sp., *Quercus cerris*, *Sabal palmetto*, *Salix* sp., *Stenotaphrum secundatum*, *Taxodium* sp., *Vaccinium* sp., and *Vitis rotundifolia*. Samples containing GR have been collected in the following 31 Florida counties: Alachua, Baker, Brevard, Broward, Clay, Collier, DeSoto, Duval, Franklin, Gulf, Highlands, Holmes, Jackson, Lafayette, Lee, Levy, Liberty, Manatee, Martin, Okaloosa, Osceola, Pasco, Putnam, St. Johns, Santa Rosa, Sarasota, Sumter, Taylor, Wakulla, Walton, and Washington.

Knowledge of the nematode races present in a country is useful in the choice of resistant rootstocks and other management and regulatory practices (4). The spectre of a physiological race which can attack burrowing nematode resistant rootstocks coupled with the lack of suitable pesticides for control suggests the need for an accelerated search for suitable germplasm.

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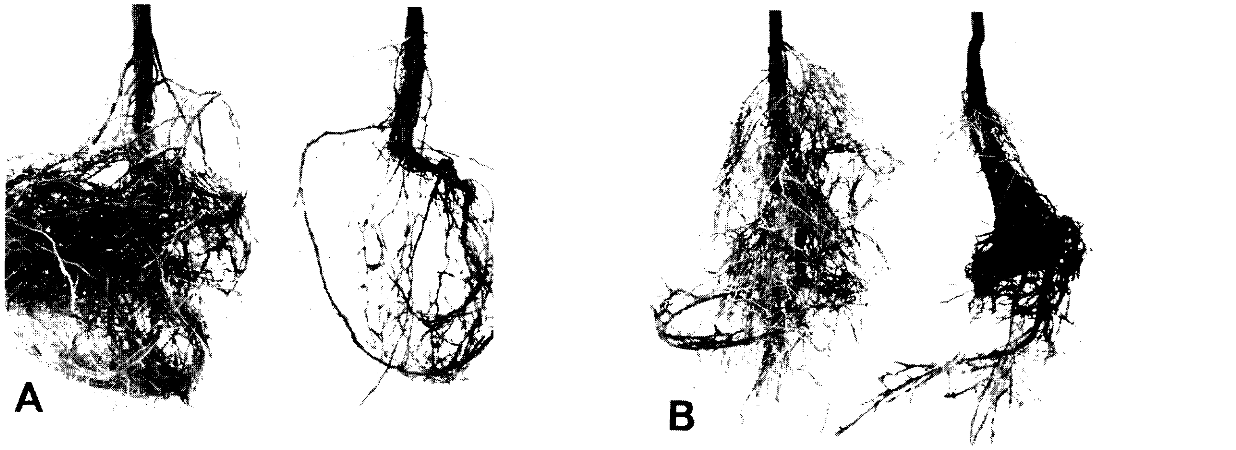

Fig. 1. A comparison of two burrowing nematode (BN) resistant rootstocks, (A) 'Milam', (B) 'Carrizo' each inoculated with two physiological races of <u>Radopholus similis</u>. The rootstocks on the left in each picture were infected with BN race 1. These rootstocks are resistant to Race 1, but susceptible to Race 2, shown on infected roots on the right in each picture.

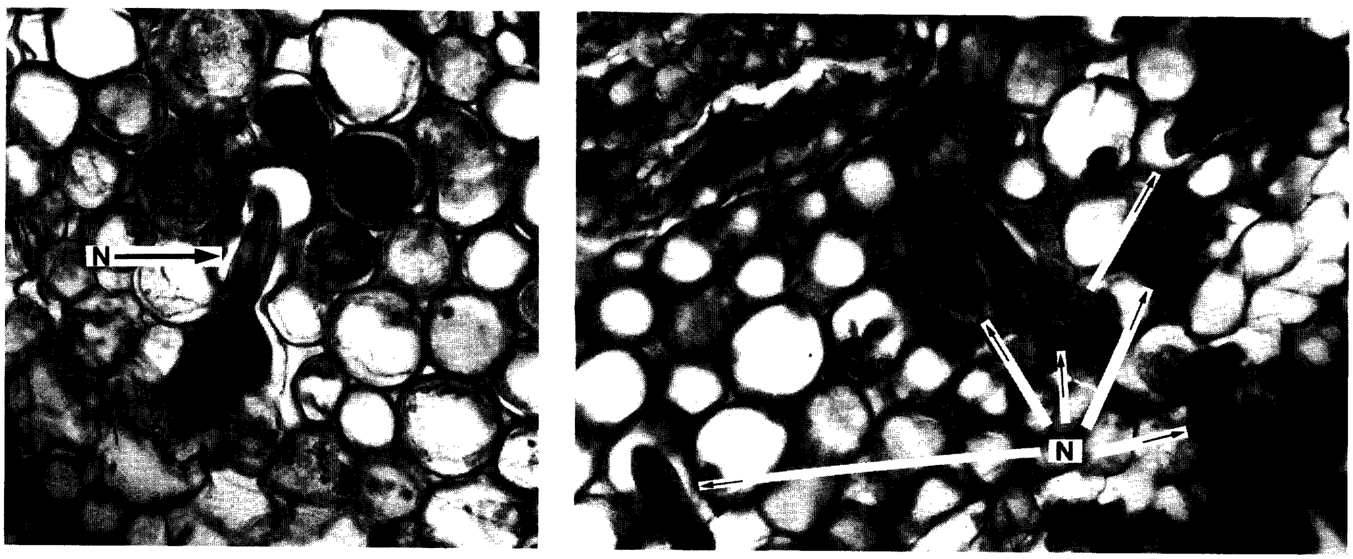

Fig. 2. Cross section of <u>Poncirus trifoliata</u> roots infected with the <u>Poncirus</u> race of <u>Tylenchulus semipenetrans</u>. Left: nematode head in cortex of root which shows central cell void of contents and surrounding densely stained nurse cells from which the nematode feeds. Right: Heavily parasitized root showing several infection sites in root cortex.

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